was increased. This demonstrates that the mode of action of decamethonium is fundamentally different from that of tubocurarine and suggests that this mode of action is not altered when tubocurarine has been previously administered.

ELEANOR ZAIMIS
THOMAS H. CANNARD
HENRY L. PRICE
Department of Pharmacology, Royal Free Hospital School of Medicine, University of London, and *Department of Anesthesiology, University of Pennsylvania Schools of Medicine, Philadelphia*

References and Notes

1. E. Zaimis, *Scientific Basis of Medicine* (1957).
2. B. Bigland *et al.*, *J. Physiol.* (*London*), in press.
3. P. E. B. Holmes, D. J. Jenden, D. B. Taylor, *J. Pharmacol. Exptl. Therap.* 103, 382 (1951).
4. This work was supported, in part, by a grant from the Office of the Surgeon General, U.S. Army (DA-49-007-MD-599).

30 January 1958

Genetic Control of Some Human Serum β-Globulins

The presence, demonstrated by two-dimensional starch-gel electrophoresis (*1*), of an additional β-globulin (D) in the serum of seven individuals (two New York negroes and five Australian aborigines) has been reported by Smithies (*2*). β-Globulin D was present in these sera in approximately the same amounts as β-globulin C. In the several hundred sera previously examined (largely from individuals of European ancestry) β-globulin D was not observed, although β-globulin C was always present.

More work has been carried out with further samples of serum from the five Australian aborigines having both β-globulins C and D, and with sera from other members of their community and race. In all, sera from over 120 aborigines (including several large families) have been examined, and a third β-globulin type has been observed in which β-globulin D is present but β-globulin C is absent. The over-all results suggest that the presence or absence of the β-globulins C and D is under simple genetic control.

The following hypothesis for the genetic control of the β-globulins C and D is completely consistent with the data obtained from the families studied. Two autosomal alleles (β^C and β^D) with no dominance are provisionally postulated. The genotype β^C/β^C leads to the presence of β-globulin C in the serum and to the absence of β-globulin D. The heterozygous combination of genes, β^C/β^D, leads to the presence of both β-globulins C and D in the serum in approximately equal amounts. The third genotype, β^D/β^D, leads to the presence of β-globulin D in the serum and to the absence of β-globulin C. This genetic hypothesis is similar to the three-allele hypothesis proposed by Smithies and Hickman for the control of the five β-globulin types which they have observed in cattle (*3*). It differs from the genetic hypothesis involving five pairs of linked genes referred to by Ashton (*4*) in an independent investigation of the β-globulin variations in cattle.

Figure 1 illustrates diagrammatically the appearance of the two-dimensional starch-gel electrophoresis patterns of the β-globulins in the three phenotypes and gives the postulated genotypes. When sera from the two homozygotes (β^C/β^C and β^D/β^D) are mixed in equal amounts, and the mixture of the two sera is subjected to two-dimensional electrophoresis, the resulting pattern of the serum proteins is indistinguishable from the pattern given by the heterozygote (β^C/β^D), as far as the β-globulins are concerned.

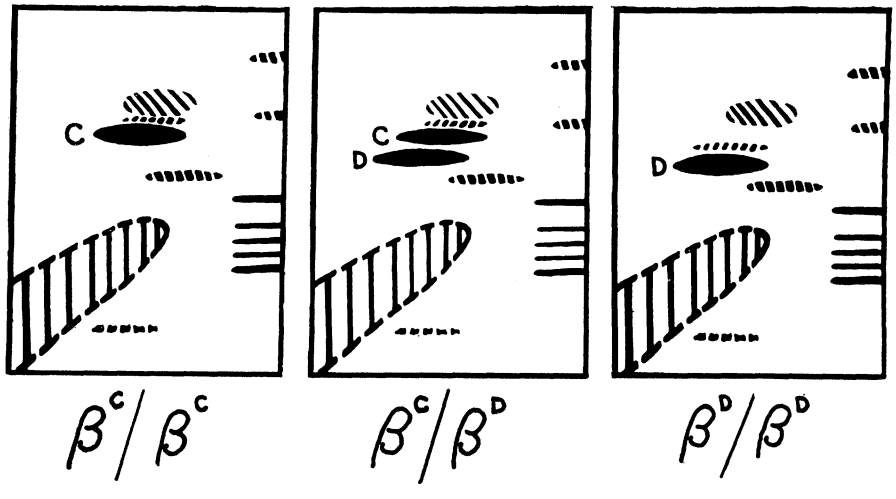

Fig. 1. Diagramatic representation of the stained proteins in the starch gels from two-dimensional electrophoresis (*1*) experiments with the serum β-globulins in the three phenotypes. β-Globulins C and D are labeled in the diagram, and the postulated genotypes are indicated. Each serum sample was first subjected to electrophoresis on filter paper, and that part of the resulting strip over which the β-globulins were distributed was then inserted into a starch gel for the second electrophoresis at right-angles to the first. The β-globulins appear in the central area of each section of the diagram; some of the γ-globulins are to the left of the β-globulins, and some of the α_2-globulins are to the right.

Table 1. Observed distribution of the β-globulin types in the sera of the offspring of those Australian aborigine families in which both parents and at least one child were tested for their β-globulin types, compared with the distribution expected from the genetic hypothesis here considered. The ratios given are (observed/expected).

Matings		Distribution of β-globulin types in offspring		
Observed	No.	βCC	βCD	βDD
βCC × βCC	6	17/17.0	0/0.0	0/0.0
βCC × βCD	6	9/ 9.0	9/9.0	0/0.0
βCC × βDD	1	0/ 0.0	6/6.0	0/0.0

Table 1 summarizes the data obtained from those of the Australian aborigine families studied in which both parents and at least one child were tested for their β-globulin types. The agreement between the observed distribution of β-globulin types in the offspring and the distribution expected from the genetic hypothesis here suggested is excellent.

The haptoglobin types (*5*) of the individuals included in the present study of serum β-globulins were also determined. The genes controlling the haptoglobin types (*6*) and those proposed for the β-globulin types were observed to segregate independently in the one family of those studied in which such independent segregation was theoretically detectable (*7*, *8*).

W. R. HORSFALL
Commonwealth Health Laboratories, Cairns, Queensland, Australia
O. SMITHIES
Connaught Medical Research Laboratories, University of Toronto, Toronto, Canada

References and Notes

1. O. Smithies and M. D. Poulik, *Nature* 177, 1033 (1956).
2. O. Smithies, *ibid.* 180, 1482 (1957).
3. O. Smithies and C. G. Hickman, *Genetics*, in press.
4. G. C. Ashton, *Nature* 180, 917 (1957).
5. The haptoglobulins are serum α_2-globulins able to bind hemoglobin; they can be classified in different persons into three types. The haptoglobulin type shown by an individual is determined by his genotype with respect to the alleles Hp^1 and Hp^2.
6. O. Smithies and N. F. Walker, *Nature* 178, 694 (1956).
7. A detailed account of these investigations is in preparation.
8. We gratefully acknowledge the help of Mr. Norman A. Ferris, superintendent of the Mona Mona Mission, in this study, and the technical assistance of Mr. Otto Hiller in the performance of the starch-gel tests.

24 December 1957